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# Spatio-temporal distribution and phase partitioning of Arctic clouds from shipborne remote-sensing observations

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Arctic clouds have a high variability in their radiative effects and in their impact on the surface energy balance. Thus, they are suspected to play a key role in the fast change of the Arctic environment, which is also known as Arctic Amplification. Yet the underlying processes controlling Arctic cloud phase and occurrence and hence the connected feedback mechanisms driving Arctic amplification are not well understood. In order to study the causes behind these changes the Polarstern cruise PS106 was performed in the Arctic summer of 2017 (June, 1st to July, 16th) around Svalbard combining several remote sensing and in-situ observations.

Due to their possibility to measure continuously the whole atmospheric column remote sensing observations are suitable to investigate the spatio-temporal distribution of the clouds, their phase partitioning and interaction with aerosols. During PS106 measurements with the multiwavelength polarization lidar (light detection and ranging) PollyXT-Oceanet, a 35-GHz cloud radar (radio detection and ranging) and a microwave radiometer HATPRO of the OCEANET platform were conducted. Performing these measurements aboard a research vessel in the Arctic resulted in two major challenges: On the one hand, a suitable correction of the Polarstern movement influencing the cloud radar measurements needed to be implemented. On the other hand, a high frequency of occurrence of low-level clouds that caused significant attenuation of the lidar beam had to be handled. The first issue was solved using an active stabilization platform to level out the rotational movement of the research vessel (RV). Additionally, in a post processing step, the influence of the vertical movement was corrected. To address the second issue a new Cloudnet classification ‘fog’ was introduced. In addition, new microphysical products to connect the observations to a radiative transfer model have been implemented.

Using this comprehensive dataset we investigate the statistical cloud occurrence during PS106, precipitation statistics and heterogeneous ice formation. The evaluation of the dataset, e.g., revealed that surface-coupled clouds appear to produce ice heterogeneously at higher temperatures than uncoupled cloud layers. This suggests an influence of surface-near aerosol in the process of heterogeneous ice formation.